JERROLD/TEXSCAN
MODEL#727

FIELD STRENGTH METER
USER'S MANUAL

KEEP WITH EQUIPMENT AT ALL TIMES

PROPERTY OF
ELECTRO RENT CORP.
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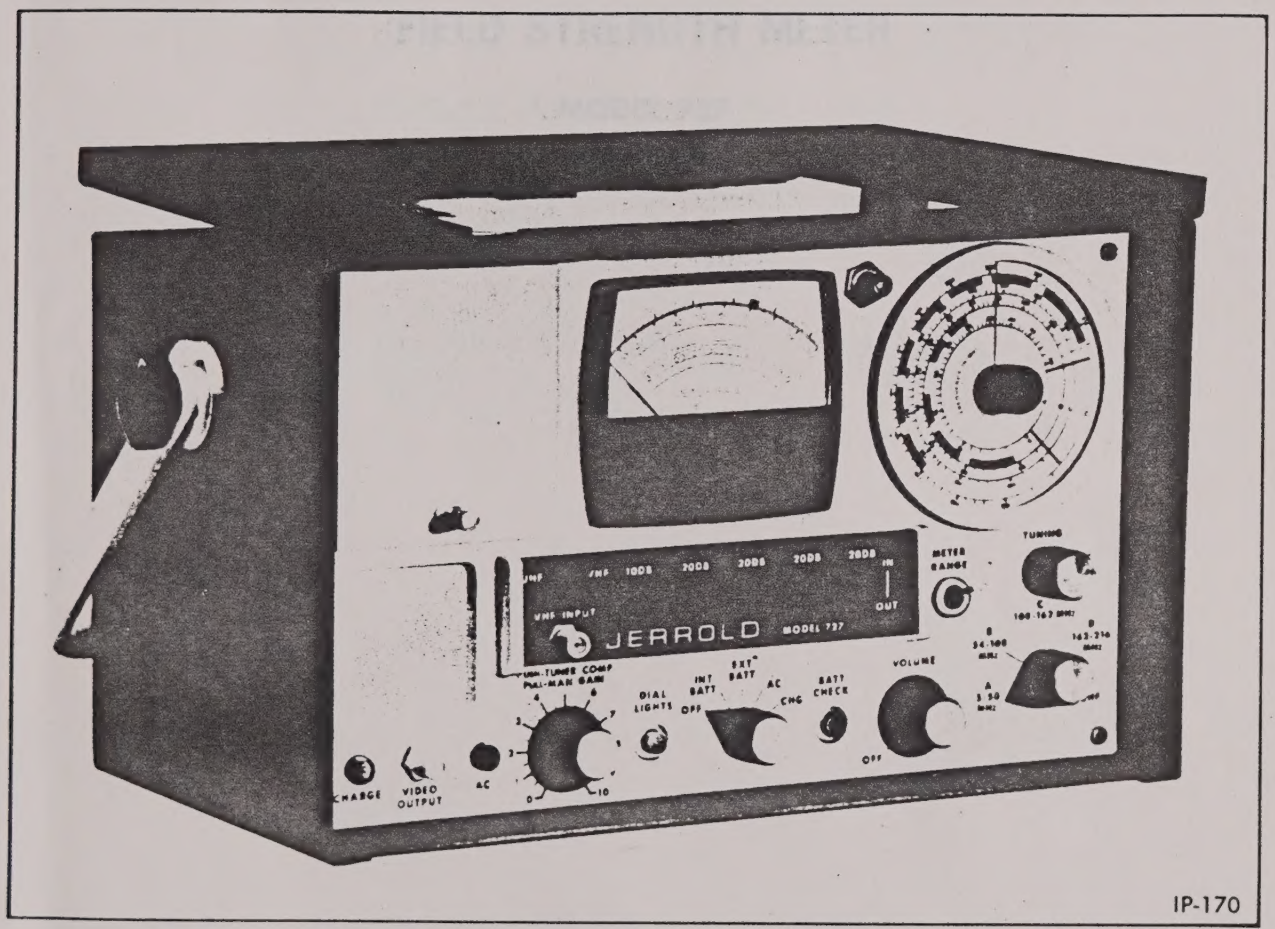
BURBANK, CA 91504
2230 CHARLESTON RD.
MOUNTAIN VIEW, CA 94043

IMPORTANT NOTICE

HANDLE WITH CARE

THIS ELECTRONIC INSTRUMENT WAS DESIGNED FOR NORMAL OPERATING AND STORAGE CONDITIONS ENCOUNTERED IN FIELD USE. IT SHOULD BE HANDLED AND TRANSPORTED WITH CARE TO AVOID DAMAGE TO DELICATE COMPONENTS AND CIRCUITS. PERSONNEL UNFAMILIAR WITH ELECTRONIC INSTRUMENTS SHOULD BE INSTRUCTED TO AVOID DROPPING, THROWING, BOUNCING, STRIKING, OR OTHERWISE MISHANDLING THE UNIT. WHEN TRANSPORTING THE UNIT IN A VEHICLE, CARE SHOULD BE TAKEN TO CUSHION IT AGAINST SEVERE SHOCKS THAT MIGHT OCCUR.



IP-170

Fig. 1-1. Model 727

JERROLD
Texscan

INSTRUCTION MANUAL
435-267-03

FIELD STRENGTH METER

MODEL 727

(Patent Pending)

JERROLD ELECTRONICS CORPORATION
Philadelphia, Pa. 19105

CAUTION:

Units shipped from the factory are identified for operation from the proper input power source. Note the following:

(1) 230-volt rms, 50/60 Hz, single-phase power source.

A RED label marked "230V" is wrapped around the power cord within six inches (15 cm) of the polarized power plug. A RED label marked "230V" is also attached to the rear panel of the unit above the line-cord grommet.

(2) 115 volt rms, 50/60 Hz, single-phase power source.

A YELLOW label marked "115V" is wrapped around the power cord within six inches (15 cm) of the polarized power plug. A YELLOW label marked "115V" is also attached to the rear panel of the unit above the line-cord grommet.

Dammage to any unit which is connected to a 230-volt power source, but which is wired internally for 115-volt operation constitutes "misuse", and is not covered by the TEXSCAN warranty. Consult the TEXSCAN instruction manual for the proper internal power-source connection if there is any question about the intended use. NOTE: The line fuse(s) must also be checked for the correct rating and type.

FIELD STRENGTH METER
MODEL 727

ADDENDUM
435-267-91

INTRODUCTION

This addendum updates information contained in Instruction Manual 435-267-03, covering Field Strength Meter Model 727.

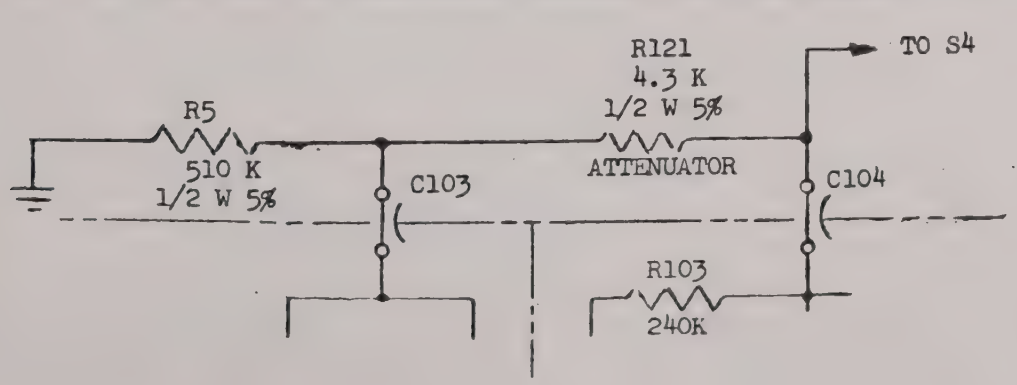
CHANGES

1. Change the following Replacement Parts List items.

ITEM	SCHEMATIC DESIGNATION	QTY.	DESCRIPTION	JERROLD PART NO.
			Page 25, I-F Amplifier	
26	R210/S201	1	400 Ω, potentiometer with spst switch	S118-236-01
			Page 26, VHF Tuner	
13	R401	1	820 Ω, 5%, 1/4 W	112-976
17A(Add)	R410	1	300 Ω, 5%, 1/4 W	112-096
			Page 26, Power Supply	
14	Q602,603	2	2N3905	130-168
			Page 26, Attenuator	
2	C102	1	0.22 pF, 10%, 500 V	122-093
13	S101	1	Spdt, slide	S162-251
14	S102-106	5	Dpdt, slide	S162-250
			Page 26, Front Panel	
11	R2	1	180Ω, 5%, 1/2 W	112-266

2. Change schematic diagrams C861-779 and E861-829 to reflect the changes indicated above.

3. On Schematic diagram E861-829, move connection to S4 from junction of R5, C103, and R121 to junction of R121 and C104 (see below).



DESCRIPTION AND SPECIFICATIONS

DESCRIPTION

Model 727 is a tunable r-f voltmeter designed for measuring signal levels between 10 microvolts and 3 volts in the frequency range from 5 to 216 MHz.

An accessory plug-in converter is available on special order for extending the operating range into the 470 to 890 MHz UHF band.

The instrument consists essentially of a tuner/local oscillator unit, a balanced mixer, an i-f amplifier, and a peak detector measuring circuit. A step attenuator in the input circuit permits setting the measurement range. Frequencies can be tuned in four switch-operated ranges.

The 727 also includes a video detector whose output is available at a front panel terminal. A discriminator, an audio amplifier, and a loudspeaker are incorporated to help in the identification of interfering signal sources. The metered signal current is also available at a rear panel phone jack for application to a strip chart recorder or similar device.

Special sampling circuitry permits identification of the meter scale from which to take a reading, simply by depressing a front panel switch.

Model 727 may be powered from a 115V or 230V, or 50 Hz or 60 Hz line source, from an external 12 to 15 volt battery, or from its own internal, rechargeable, nickel-cadmium battery. Each instrument is accompanied by a calibration chart inserted in a special holder in the lid; the compensator calibration points are factory-inserted on the chart.

1.2 SPECIFICATIONS

The specifications of Model 727 are listed in Table 1-1.

TABLE 1-1. SPECIFICATIONS

FREQUENCY RANGE Tuning Range A B C D	5 to 50 MHz, 54 to 216 MHz, in 4 bands 5 to 50 MHz 54 to 108 MHz 108 to 162 MHz 162 to 216 MHz
MEASUREMENT RANGE full scale reading	10 microvolts to 3 volts in 10 ranges: 0.1 mV, 0.3 mV, 1.0 mV, 3.0 mV, 10.0 mV, 30.0 mV, 0.1 V, 0.3 V, 1.0 V, 3.0 V.
ACCURACY OF LEVEL READINGS	±1.5 dB at 25°C, ±3 dB from —18°C to +60°C.
VIDEO OUTPUT CAPABILITY	0.8 V p-p for +10 dBmV input, with compensator control set for no overload.
MAXIMUM SENSITIVITY	10 microvolts.
SELECTIVITY	I-F bandwidth of 0.6 MHz at 3-dB points.
REJECTION OF ADJACENT SOUND CARRIER	46 dB down from level of received video carrier.
INPUT IMPEDANCE AND MATCH above 100 microvolts	75 ohms, VSWR 1.22:1 (20 dB min. return loss); not matched below 100 microvolts.
INTERMEDIATE FREQUENCY	52 MHz.
POWER REQUIREMENTS	A-C Line: 2 W, 115 V or 230 V (±10%), 0.3 A max. Internal Battery: 12 V, 0.6 Ah, 30-40 mA. External Battery: 12—15 V, at least 0.6 Ah.
AMBIENT OPERATING TEMPERATURE RANGE	—18°C to +60°C.
AMBIENT STORAGE TEMPERATURE RANGE	—40°C to +60°C.
NET WEIGHT	15 lbs.
DIMENSIONS	8½" H x 13¼" W x 8¼" D.

OPERATION

2.1 OPERATING CONTROLS AND CONNECTIONS

The operating controls and connections of Model 727 are listed in Table 2-1.

TABLE 2-1. OPERATING CONTROLS AND CONNECTIONS

LOCATION	NAME	TYPE AND SCHEMATIC DESIGNATION	POSITION	FUNCTION
FRONT PANEL	CHARGE	Lamp, DS2	——	Indicates unit is operating to charge internal battery.
	VIDEO OUTPUT	Coaxial fitting, J5	——	For connection of an oscilloscope.
	AC	Neon lamp, DS1	——	Indicates unit is operating from a-c line.
	PUSH—TUNER COMP	Potentiometer and switch, R210/S201	Pushed in, 0-10	Permits calibration of unit over its frequency range.
	PULL—MAN GAIN		Pulled out	Provides uncalibrated 27 dB range gain control for the i-f amplifier; the meter readings are relative with the control in this position.
	Power Selector	Rotary switch, S1-A/S1-B	OFF INT BATT EXT BATT CHG	De-energizes the instrument. Connects internal battery. Connects external battery. Permits charging int. battery from a-c line.
	DIAL LIGHTS	Pushbutton switch, S2	——	Controls tuning dial lights and meter lights.
	UHF/VHF	Slide switch, S101	UHF	Connects the UHF converter output for measurement.
			VHF	Connects the VHF input for measurement.
	VHF INPUT	Coaxial fitting, J801		For connecting VHF signal source.
	10 dB, 20 dB	Slide switches, S102 thru S106	IN	Insert attenuation for selection of measurement range.
			OUT	Remove attenuation.
	METER RANGE	Toggle switch, spring-loaded, S4	Down	Connects sampling network into metering circuit to indicate meter range.
	Meter	0-200 μA meter M1	0-300 and 0-100 scales, black	Indicate voltage levels.
			—10 to +10 dB scale, red	Indicates dB levels.
			VOLTS/MILLIVOLTS scale, black	Indicates measurement range in volts.
			BATT mark, red	Indicates full charge on internal or external battery when BATT CHECK switch is pressed.
	TUNING	Inductive, L402, L405, L408, L411	Clockwise and counter-clockwise	Permits tuning to desired frequencies.
		Dial	A, B, C, and D scales	Indicate tuning ranges; black bands indicate ranges between video and sound carriers of each VHF TV channel.
	BATT CHECK	Pushbutton switch, S5	Depressed	Permits checking charge on internal or external battery, and output voltage of internal power supply when unit is connected to a-c line.
	VOLUME	Potentiometer and spst switch, R7/S6	OFF	De-energizes audio amplifier.
			——	Controls audio volume.
	Frequency Range Selector	Rotary switch, S701	A/5-50 MHz	Selects 5- 50 MHz range.
			B/54-108 MHz	Selects 54-108 MHz range.
			D/108-162 MHz	Selects 108-162 range.
			C/162-216 MHz	Selects 162-216 MHz range.
			UHF	Selects operation with UHF adapter.
REAR PANEL	RECORDER	Phone jack, J1	——	Permits connection of a recording device.
	FUSE 0.5 A	3AG, F1	——	Protects instrument against surge currents.
	—(BLK) EXT +(RED) BATT	Tip jack, black, J4 Tip Jack, red, J3	—— ——	Permits connection of instrument to external battery
	115/230 VAC 50/60	Recessed, 3-prong male jack, J1	——	Accepts female plug of line cord
INTERNAL	Power Selector (115/230)	Slide switch, S7	115	Permits operating unit from 115 V a-c line
			230	Permits operating unit from 230 V a-c line

2.2 SETTING THE MEASUREMENT RANGE

Table 2-2 lists all the measurement ranges obtainable from settings of the 727 attenuator switches.

Each measurement range can be checked and identified simply by pressing the METER RANGE switch. Note that the "1" ranges are on the lower (0-100) mV scale and the "3" ranges are on the upper (0-300) mV scale. The dBmV figures in the table indicate the signal level for a 0 (zero) reading on the dB scale.

TABLE 2-2. MEASUREMENT RANGES

ATTEN. SETTING dB	MEASUREMENT RANGE		USE mV SCALE
	mV or V	dBmV	
0	0.1 mV	—30	0-100
10	0.3 mV	—20	0-300
20	1.0 mV	—10	0-100
30	3.0 mV	0	0-300
40	10.0 mV	+10	0-100
50	30.0 mV	+20	0-300
60	0.1 V	+30	0-100
70	0.3 V	+40	0-300
80	1.0 V	+50	0-100
90	3.0 V	+60	0-300

2.3 USING THE dB AND dBmV SCALES

Model 727 is calibrated to read signal levels directly in microvolts rms; however, dB and dBmV scales are included for applications where signal level is more conveniently expressed in these terms.

For example, assume a 600-microvolt signal is being measured with the 727 operating in the 1 mV/—10 dBmV measurement range. A 600 μV reading corresponds to a +5.5 dB reading on the dB scale. Adding algebraically —10 and +5.5 we get —4.5 dBmV for the signal level.

2.4 MEASURING VHF SIGNAL LEVELS

1. Set the power selector switch according to the power source to be used.
2. If an a-c line source is to be used, remove the line cord from its compartment at the rear of the instrument and connect the cord there to the recessed 3-prong jack.
3. If an external battery is to be used, connect the battery leads to the red (positive) and black (negative) tip jacks at the rear of the instrument. Take care in observing polarity and heed the caution on the label.
4. When using an internal or external battery, press the BATT CHECK switch to see that the meter needle points to the red BATT mark on the meter scale. This check will also indicate the correctness of the internal power supply output voltage when the instrument is operated from the a-c line.
5. Connect the VHF signal source to the VHF INPUT terminal on the front panel.
6. Set the UHF/VHF switch to VHF.
7. Set the tuning range selector switch as required.
8. Push in the compensator control and turn it to the setting indicated on the calibration chart in the lid of the 727 for the frequency nearest that of the signal under test.
9. Tune the 727 back and forth past the signal frequency, adjusting the attenuator until the meter indicates between 0 and +10 on the dB scale when the 727 is tuned for maximum reading (this condition will not be attainable for readings below 30 microvolts).
10. Press the METER RANGE switch and note the measurement range indicated by the meter needle.
11. Release the switch and read the signal level.

2.5 OPERATION FROM A 230V A-C LINE

The meter is shipped from the factory with the Power Selector switch set to 115. To operat the unit from a 230 V line, first remove the chassis from the cabinet by removing the four binding-head screws at the rear of the cabinet and pulling the chassis out from the front. Then set the switch, located at the rear of the chassis near the lower right corner, to the 230 V position. Return the chassis to the cabinet.

2.6 RECHARGING THE INTERNAL BATTERY

The 727 is equipped with a rechargeable nickel cadmium battery. Because the state of charge of the battery when the instrument is received by the customer cannot be known, Jerrold recommends that the battery be charged for 14 to 24 hours before the instrument is operated on battery power.

When a nickel cadmium battery with series connected cells, such as the one used in the 727, is discharged too deeply, the weak cells are reverse-charged by the stronger ones. If recharging of the battery is attempted under this condition, the reverse-charged cells will be damaged by the charging current. For this reason, it is essential that the battery not be allowed to discharge too deeply.

Jerrold recommends that for cases where the meter is operated only occasionally on battery power, a 14 to 24 hour charge be given every two weeks. Where the unit is battery-operated frequently, it should be left on charge every night.

The battery is charged as follows.

1. Use the line cord to connect the instrument to an a-c source.
2. Open the lid.

Note

The lid must remain open during the charging period: when the lid is closed, an interlock switch disconnects the battery.

3. Set the power selector switch to CHG.

4. The initial charge should extend over a period of from 15 to 20 hours. Since the charging current flows through the CHARGE lamp, the lamp will glow brightly at first and grow dimmer gradually as the battery approaches full charge. If the lamp does not light the battery is not charging.

5. After this initial charge, follow the procedure outlined on the line cord compartment lid, remembering to keep the front lid open during the charging period.

APPLICATIONS

3.1 GENERAL

Model 727 has application where measurements of relative or absolute r-f signal levels are to be made. In addition, the video detector in the unit allows application in the measurement of a detected signal on a calibrated oscilloscope. This section of the manual describes how to use the instrument for various kinds of r-f measurements.

3.2 FIELD INTENSITY SURVEYS

Model 727 can be used together with a 75-ohm resonant dipole for plotting detailed field intensity contour maps necessary for choosing antenna sites for CATV systems. For these measurements the 727 and the antenna are moved about in a vehicle and signal strength readings are plotted on an area map. These readings are then converted to field strength indications using the following equation:

$E = 0.021\ fV$; where E is the field strength in μV/m (microvolts per meter),
f is the signal frequency in MHz, and
V is the 727 reading in μV.

Table 3-1 is the result of using this equation to obtain conversion factors (C) for the video carrier frequency of every VHF television channel. Using these factors, the above equation reduces to: $E = CV$.

TABLE 3-1. CONVERSION FACTORS FOR FIELD INTENSITY SURVEYS

CHANNEL	C	CHANNEL	C
2	1.20	8	3.84
3	1.32	9	3.97
4	1.45	10	4.10
5	1.66	11	4.22
6	1.79	12	4.35
7	3.72	13	4.47

If an antenna other than a resonant dipole is used for making the measurements, the gain factor (G) of the antenna must be taken into account (for example, for an antenna with 20 dB of gain, the gain factor G = 10) and the equations become:

$$E = \frac{0.021fV}{G} \text{ and } E = \frac{CV}{G}$$

3.3 ORIENTING ANTENNAS

Model 727 can be employed for orienting antennas for best reception. The antenna down lead is connected to the VHF INPUT terminal (if necessary, through a matching transformer) and the antenna is then oriented for maximum reading of the video carrier signal on the 727.

For the case of a single-channel antenna, the 727 is tuned to the video carrier of the channel and the antenna is oriented according to the reading on the 727.

For the case of broadband antennas, the 727 reading is maximized for the video carrier of each channel to be received, noting the reading and orientation for each channel. A compromise orientation is then selected on the basis of these readings and orientations. Readings are repeated for each channel with the antenna in the compromise orientation to assure that adequate signal strength is available for each channel. The procedure for f-m antennas is the same as that for broadband antennas.

3.4 MEASUREMENT OF GAIN AND LOSS

For measuring gain or loss of a circuit at specific frequencies proceed as follows:

1. Set up the equipment as shown in Fig. 3-1.

2. Tune the 727 and the signal generator to the test frequency.

3. Measure and record the signal level at the input to the circuit under test.

4. Measure and record the signal level at the output of the circuit under test.

5. The gain or loss is the difference between the two readings obtained. For example, if the

input signal level is 5 dBmV and the output signal level is 1 dBmV, the circuit has a loss of 4 dB. If the output level is 40 dBmV for an input level of 5 dBmV, the circuit has a gain of 35 dB.

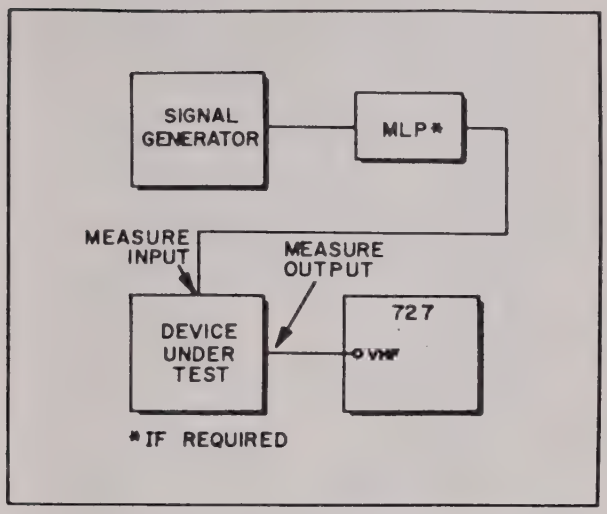


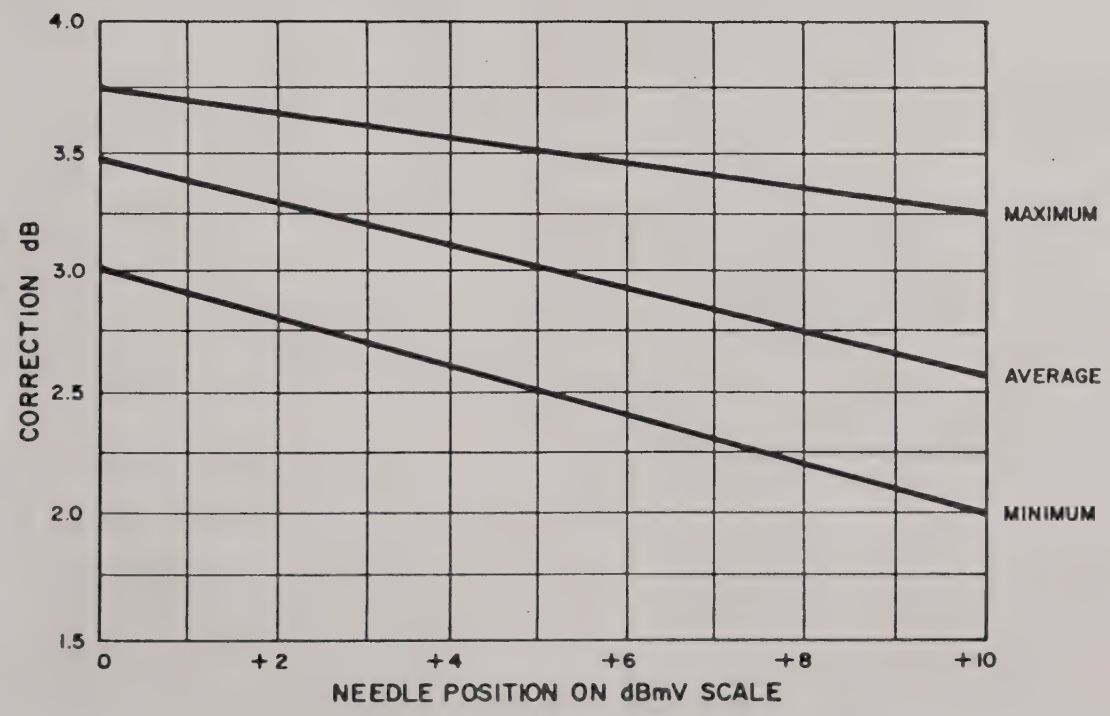
Fig. 3-1. Setup for Gain and Loss Measurements

6. Readings are obtained at a number of points across the passband of the circuit and the results are plotted to obtain an approximation of the response curve.

3.5 MEASUREMENT OF NOISE LEVELS

Although the 727 meter scale is not calibrated for noise level readings, with proper correction of readings taken the instrument can be used for measuring noise levels in CATV systems. The corrections are necessary for two reasons: First, since noise levels in CATV systems are usually specified for a bandwidth of 4 MHz while the i-f bandwidth of the 727 is only 0.6 MHz, the meter readings would be about 8 dB low (noise power is proportional to bandwidth, hence a power ratio of 4:0.6 equals 6.7 which corresponds to 8.2 dB).

The second error source, having an effect opposite to that above, is the response to noise of the peak detector in the 727. Since the detector is designed to respond to the peak of the television picture signal, the instrument indicates peak noise rather than rms noise. As noise has a higher peak-to-rms ratio than a c-w signal, the detected output reads high, reducing the correction required.



To obtain noise levels for 4-MHz bandwidth:

a. Measure noise level as if it were signal level.

b. To meter reading add the average correction shown opposite needle position.

Fig. 3-2. Correction Curves for Noise Level Measurements

However, at reduced output levels the efficiency of the detector decreases and the detected noise reading is closer to rms; hence more total correction is needed for readings taken at the low end of the meter scale.

With these considerations in mind, noise calibration tests were made on a number of Models 727 chosen at random. The resulting correction curves are shown in Fig. 3-2. The curves indicate the maximum and minimum corrections found necessary for the tested units and the resultant average curve. The latter is sufficient for corrections of noise level measurements where an accuracy of plus or minus 0.75 dB is acceptable. For greater accuracy, the individual instrument would have to be calibrated from an accurately known noise source (Section 3.6).

For using the average curve in determining, for example, the S/N ratio in a trunk line, proceed as follows:

1. Connect the output of the last trunk line amplifier to the VHF INPUT terminal on the 727.
2. Disconnect the head-end output from the input to the first amplifier in the trunk line; but do not disconnect the standby carrier signal, which is needed for normal AGC operation.
3. Tune the 727 to the highest and the lowest channel carried on the system and record the meter readings as if a signal were measured.
4. Obtain the correct noise levels for both channels by adding the corrections taken from the average curve; or, for greater accuracy, from the noise calibration record of the particular Model 727.
5. Subtract the corrected noise levels from the signal levels of both channels at the output of the last amplifier to obtain the S/N ratio at that point.

3.6 NOISE CALIBRATION OF A MODEL 727

This section describes a convenient method of calibrating a 727 by using an amplifier whose noise figure is accurately known. Fig. 3-3 shows the equipment setup. The input to the amplifier with known noise figure is terminated accurately in 75 ohms and its output is connected through a variable attenuator to the input of a second amplifier. The output of the latter is then connected to the VHF INPUT terminal of the field strength meter.

Calibration is done as follows:

1. Tune the 727 to a convenient channel having no local signal. Set the 727 step attenuator to 10 dB for a full-scale indication of −10 dBmV (0.3 mV) then adjust the tuner compensator to the calibrated point.
2. Adjust the variable attenuator for full-scale reading on the meter.

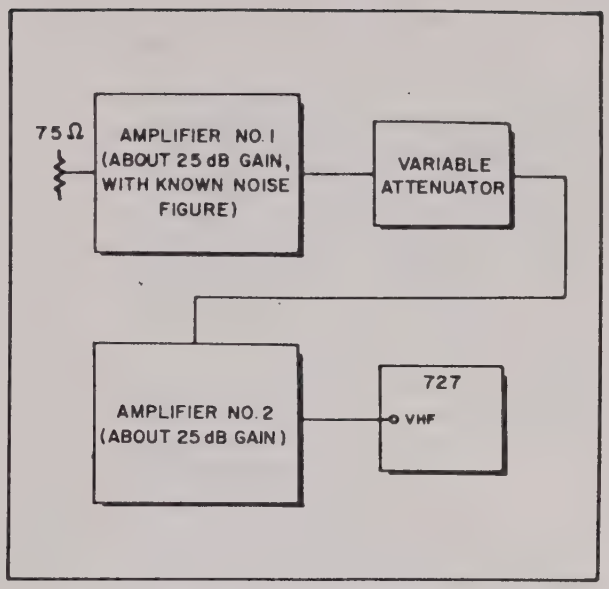


Fig. 3-3. Setup for Noise Calibration of a 727

3. Now measure the gain from the input to the first amplifier to the output of the second amplifier, then measure the noise figure at the input of the first amplifier. If the net gain from the input of the first amplifier to the input of the second amplifier is over 15 dB, it is safe to assume that the noise figure of the combination is the same as that of the first amplifier.
4. As the minimum noise level in any 75-ohm system is −59.2 dBmV, the noise output of the combination into the field strength meter is: −59.2 + N.F. + Gain. If, for example, the noise figure measured were 8.4 dB and the net gain measured were 44.5 dB, the noise output of the combination would be: −59.2 + 44.5 + 8.4 = −6.3 dBmV.
5. The correction for the 727 at full scale is the number of dB that must be added to the reading to equal this calculated noise level. In our example: −6.3 = −10 + X, and X = 10 −6.3 = 3.7 dB.
6. Find the corrections required at other points of the scale by adding attenuation in 1 dB steps, noting after each step how far below the dB marks the meter needle reads.

3.7 MEASUREMENT OF PERCENT CROSS-MODULATION

Model 727 can be employed in a simple test setup for making reasonably accurate percent cross-modulation measurements in the field, using the signals available in a TV distribution system. While the method described here is sensitive enough for measurements in an operating distribution amplifier, it is not sensitive enough for measurements in individual trunk line amplifiers operating at their normal system levels.

Fig. 3-4 shows the equipment set-up. The required signals are obtained from the system or directly from the head-end converters (for example from Channel Commanders). The c-w signal is obtained from a c-w generator or from the standby carrier condition of the converter concerned.

To obtain meaningful results, modulation on all channels other than the one under test should be synchronous. Where tunable converters are used, this can be accomplished by tuning them all to receive the same channel.

The high-pass filter in the set-up passes any cross-modulation components (around 15 kHz) but blocks hum components (around 60 Hz) so that the latter will not obscure the measurement of cross-modulation. Operating the 727 on battery power will eliminate one possible source of hum contribution.

Measurement is done as follows:

1. Introduce the c-w signal on one channel, and interfering signals on other channels as required, through the input attenuator to the input terminal of the distribution amplifier, or the first trunk line amplifier of the system under test.

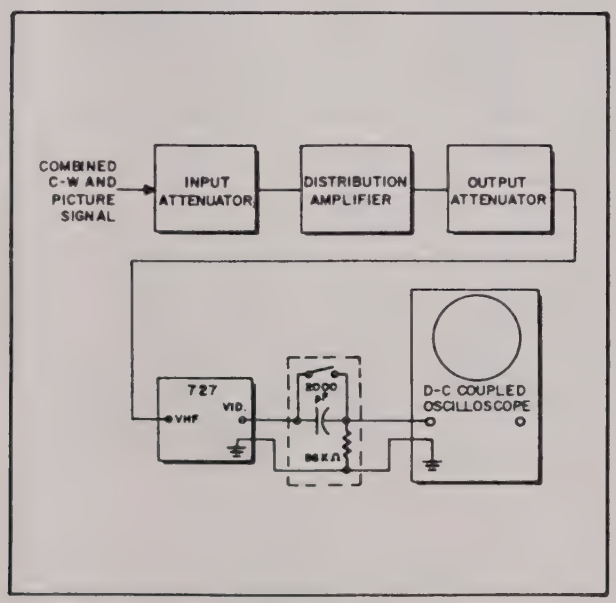


Fig. 3-4. Setup for Percent Cross-Modulation Measurements

2. Connect the 727 through a second attenuator to the output of the distribution amplifier, or the last trunk line amplifier of the system; set the channel levels and the input attenuator to give rated output on each channel; note the meter reading.

3. Tune the 727 to the c-w signal frequency. Reduce the attenuation in the output attenuator by 20 dB and set the 727 manual gain control to obtain the same meter reading as in step 2.

4. Close the filter bridging switch. Set the oscilloscope for operation in the d-c mode and in the 0.1V/cm vertical sensitivity range. Position the reference trace on the bottom line of the oscilloscope screen and increase the input to the 727 by reducing attenuation in the output attenuator until reference signal and c-w signal differ by 0.8 V; the 727 manual gain control can be used for fine adjustment.

5. Switch the oscilloscope to the next higher sensitivity range and adjust the oscilloscope gain until the c-w trace is 10 divisions above the reference trace; each division now represents 10% cross-modulation.

6. Open the filter bridging switch and change the oscilloscope to a-c operation, increase the vertical sensitivity 10 times; one division on the screen now represents 1% cross-modulation. The c-w trace can now be observed for exhibiting any modulation due to the presence of other channels in the system.

With one interfering channel, or when all interfering channels have a common sync source, the indicated cross-modulation will vary somewhat with the degree of white in the interfering picture signal. Exact percentage of cross-modulation is therefore determined by observing the oscilloscope until a maximum of cross-modulation is seen; this will occur when there is maximum variation in the interfering signal.

When the interfering signals derive their sync from various sources, their horizontal line frequencies will differ slightly so that relative timing of the various horizontal sync pulses will change constantly. In this case, maximum cross-modulation will occur when a number of sync pulses coincide; it will be necessary to observe the oscilloscope for a longer period to see this happen and to arrive at a reasonably exact percent cross-modulation corresponding to this condiiton.

To be sure that there is no cross-modulation in the 727 circuits or in the mixing networks in which the various input signals are combined, it is advisable to test for cross-modulation first without the amplifier or system in the circuit. Adjust for equal levels at the 727 input, tune to the c-w signal and then measure for cross-modulation as above.

Note

The video output of the 727 is specified at 0.8 volt p-p at full-scale meter indication. When using an oscilloscope with a sensitivity of 1 mV/cm, the gain can generally be increased up to 25 times for a maximum sensitivity of 0.4% cross-modulation per division.

When picture signals are not available, the signals from laboratory signal generators with sine-wave modulation can be used for measuring cross-modulation. Because of the different form of modulation, corrections must be made if the results of this measurement method are to agree with those obtained when using television signals.

Table 3-2 lists the corrections to be applied and Fig. 3-5 diagrams the test set-up.

Test Procedure:

1. Tune one signal generator to the picture carrier of channel 2 (55.25 MHz), the other to that of channel 13 (211.25 MHz).
2. Combine the outputs of the two generators in a Jerrold Model LHS-76 high-band/low-band mixer to prevent cross-modulation between the two bands.
3. Apply the LHS-76 output to the input of a variable attenuator, the output of this attenuator to the input of the amplifier under test, the output of the amplifier to the input of a second variable attenuator and the output of this attenuator to the VHF INPUT terminal on the 727; finally the VIDEO OUT terminal of the 727 is connected to the vertical input of the oscilloscope.
4. Preferably use the 727 on internal battery power to avoid hum pick-up. If the instrument has to be used on a-c power, use a 2-pin adapter on the 727 line cord plug.
5. Set the oscilloscope to operate in the d-c mode.
6. Apply a modulation of 1 kHz to the 55.25 MHz signal, then set the input attenuator for 10 dB and the output attenuator for 20 dB.

TABLE 3-2. CORRECTIONS FOR CROSS-MODULATION MEASUREMENTS

On Interfering Signal		To Obtain Cross-Mod. Corresponding to TV Signal Modulation:	
% Modulation (for symmetrical Mod.)	Modulation Ratio $\frac{E\ min}{E\ max}$	Multiply Indicated % Cross-Mod. by	or Add dB to Indicated Cross-Mod.
10	0.818	2.97	9.5
20	0.666	1.77	4.9
30	0.538	1.39	2.9
40	0.429	1.21	1.7
50	0.333	1.11	0.9
60	0.250	1.06	0.5
70	0.177	1.02	0.2
77.8**	0.125	1.00	0.0
80	0.111	1.00	0.0
90	0.053	0.99	—0.1
100	0.000	0.99	—0.1

*The derivation of the correction figures is explained in TECHNICAL HANDBOOK FOR CATV SYSTEMS by Ken Simons.
**Corresponding to full modulation of a TV signal.

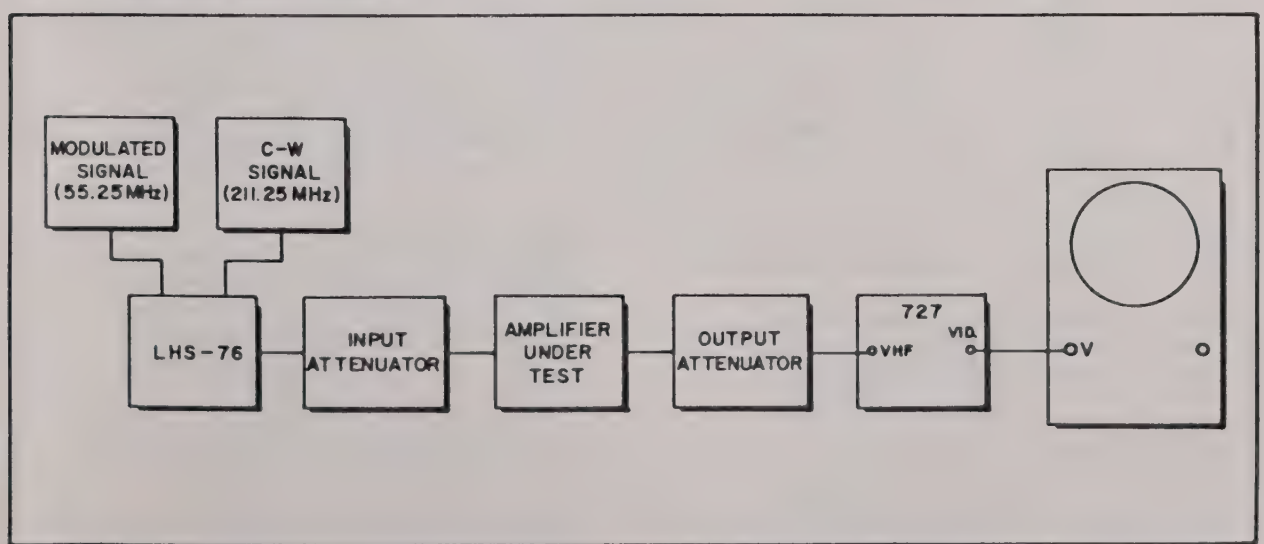


Fig. 3-5. Setup for Cross-Modulation Measurements When Using Signal Generators With Sinewave Modulation

7. Adjust the generator outputs for rated output levels of the amplifier at both frequencies, taking into consideration the attenuation in the output attenuator.
8. Disconnect the oscilloscope input signal and set the oscilloscope vertical sensitivity and centering controls so that 0 signal reference is on the bottom line of the screen.
9. Reconnect the oscilloscope input signal and tune the 727 to the modulated signal (55.25 MHz); then adjust the oscilloscope vertical gain control so that the top of signal trace is at the top of the screen (an oscilloscope with a 10 cm grid is assumed).
10. Select a convenient percent modulation figure from Table 3-2; e.g. 30%. Adjust the modulation control on the 55.25 MHz generator so that the bottom of the signal trace is 5.4 divisions (for 30% modulation) above the reference trace, while keeping the top of the signal at the 10th division by adjusting the oscilloscope vertical gain control.
11. Maintain the general output levels as in step 7 while adjusting the modulation control on the 55.25 MHz generator. Then remove 20 dB from the 727 step attenuator, pull the 727 TUNER COMP/MAN GAIN control to the MAN GAIN position and set it for the same meter reading as in step 7.
12. Set the oscilloscope vertical sensitivity to the calibrated 0.1V/cm range, remove the oscilloscope input signal and reset the vertical centering to place the 0 signal reference on the bottom line of the screen. Then reconnect the oscilloscope input signal.
13. Remove attenuation from the output attenuator until the 727 video output reads 0.8 V on the oscilloscope; fine adjustment can be made with the 727 MAN GAIN control.
14. Switch the oscilloscope to the next higher gain range and check for modulation as in step 10. If the modulation is not the same as in step 10, push the 727 TUNER COMP/MAN GAIN control to the TUNER COMP position and repeat the procedure from step 7 onwards.
15. With the 727 video output at 0.8 V peak modulation level, adjust the oscilloscope vertical sensitivity so that the top of the signal trace is on the 10th division of the screen; each major screen division now represents 10% apparent cross-modulation.
16. Switch the oscilloscope to operate in the a-c mode and increase vertical sensitivity 10 times; each major screen division now represents 1% apparent cross-modulation.
17. Tune the 727 to the c-w signal frequency (211.25 MHz); since the 727 meter will now read off scale, tune for maximum deflection of the oscilloscope display.
18. Obtain true percent cross-modulation by multiplying the measured apparent cross-modulation by the correction factor for the percent modulation of the interfering (modulated) signal. Hence, for our example true percent cross-modulation is 0.8% x 1.39 = 1.1%.

3.8 MEASUREMENT OF HUM MODULATION

Since most r-f amplifiers are powered with 60 Hz a-c, the possibility exists that power supply ripple will modulate the signal passing through the amplifier. To measure this type of modulation with the 727 proceed as follows:

1. Connect the equipment as diagrammed in Fig. 3-6. Use a General Radio Type 274-MB twin banana plug at the vertical input of the oscilloscope and insert a 20,000 pF capacitor between the input and the oscilloscope chassis ground for filtering out noise. Also, to minimize stray hum loops, be certain that there is no ground connection to the oscilloscope chassis other than the input cable shield. If the oscilloscope has a 3-pin plug on its line cord, attach a 2-pin adapter. Operate the 727 on battery power, eliminating the possibility of the meter itself contributing hum.

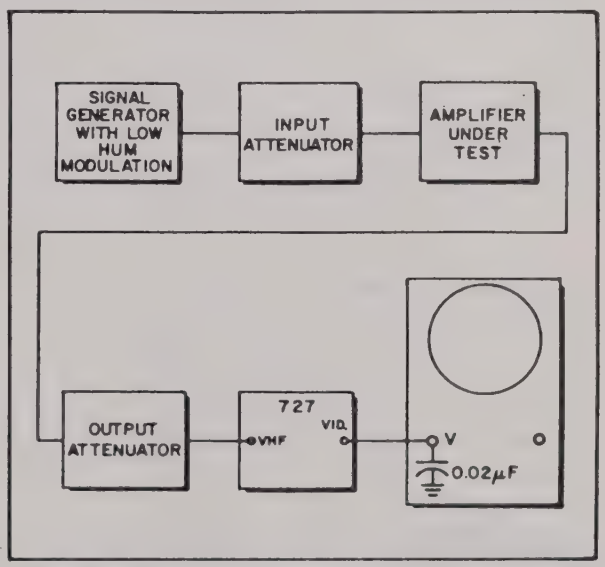


Fig. 3-6. Setup for Measuring Hum Modulation

2. Sync the oscilloscope to the line frequency, then tune the generator and the 727 to a convenient frequency; the center of the amplifier pass band is a good choice.
3. Set the oscilloscope to d-c coupling and the 0.1 V/cm range. Adjust the input to the amplifier or system under test so that the output is at normal operating level, keeping a minimum of 10 dB in the 727 step attenuator.

4. Remove 20 dB from the output attenuator, then pull the TUNER COMP/MAN GAIN control to the MAN GAIN position and set it for the same meter reading as in step 3.

5. Remove the oscilloscope input signal and adjust vertical centering so that the 0 signal trace is displayed on the bottom line of the screen.

6. Reconnect the oscilloscope input signal and remove attenuation from the output attenuator until the trace of the modulated signal is 8 divisions above the reference trace, indicating 0.8 V (assuming a 10 cm grid on the screen); fine adjustment can be made with the 727 MAN GAIN control. If appreciable modulation is present, center the trace on the 8th grid line.

7. Switch the oscilloscope vertical sensitivity to the next higher range and remove the oscilloscope input signal. Then adjust vertical centering to reset the 0 signal trace on the bottom line of the screen.

8. Reconnect the oscilloscope input signal and adjust the oscilloscope gain until the modulated signal trace is centered on the 10th grid line. Then set the oscilloscope for a-c coupling and center the trace for convenient measurement of the peak-to-peak amplitude. Each major division on the screen now represents 5% modulation (or 26 dB down from a 100% modulated signal), since a 5% modulated signal has a 5% excursion in both directions from its zero modulation level.

9. For example, if the peak-to-peak amplitude of the trace covers 1.5 major screen divisions, the hum modulation is 1.5 x 5% = 7.5% (or 22.5 dB down from a 100% modulated signal).

10. If the modulation is less than 5%, increase the oscilloscope vertical sensitivity 10 times; each major division on the screen now represents 0.5% modulation (or 46 dB down from a 100% modulated signal). By a further sensitivity increase of 5 times, modulation as low as 0.1% can be displayed on the screen.

3.9 MEASUREMENT OF SYNC CLIPPING

The normal sync signal accounts for approximately 25% of the total amplitude of a composite television video signal. Determining whether or not an amplifier or system of amplifiers is clipping the sync signal can be done with the 727 as follows:

1. Connect the equipment as diagrammed in Fig. 3-7.

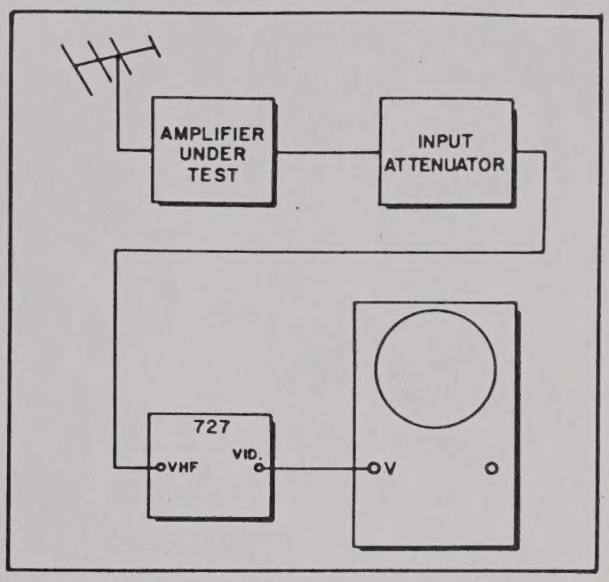


Fig. 3-7. Setup for Measuring Sync Clipping

2. Tune the 727 to the video carrier of a TV channel and adjust the amplifier or system for normal operational output.

3. Set the oscilloscope for d-c coupling and vertical sensitivity to calibrated 0.1 V/cm.

4. Increase the input to the 727 by removing attenuation from the input attenuator and by fine adjustment of the 727 MAN GAIN control until the meter reads the same as in step 2.

5. Increase the signal input to the 727 by adjusting the input attenuator until the sync pulse tips are 8 divisions above the reference trace, corresponding to 0.8 V.

6. Insert 2.5 dB in the input attenuator and note the position of the sync tip on the screen; it represents 25% amplitude.

7. Set the input attenuator to 0 dB and observe the position of the sync pedestal back porch on the screen. If the back porch falls appreciably above the line noted in step 6, the sync signal is being compressed.

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